BELLCOMM, INC.
955 L'ENFANT PLAZA NORTH, S.W. WASHINGTON, D. C. 20024

B70 08030

SUBJECT: Experiment Data Handling and Analysis on Future Space Missions - Case 105-8

DATE: August 14, 1970

FROM: R. J. Pauly

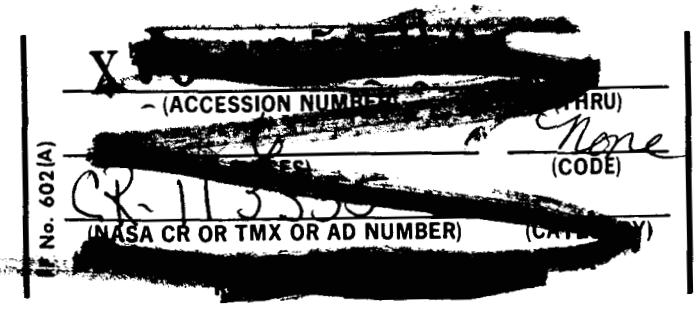
ABSTRACT

Future long duration Space Station/Space Base missions will be capable of producing 7.5×10^{11} to 1.0×10^{13} bits per day. This would be 200 to 3000 times the amount of data that is currently being handled from all scientific satellites at the Goddard Space Flight Center Central Processing Facility.

An examination of current data handling activities indicates that data is already being received faster than it can be processed and analyzed. There is obviously a need to make it easier for experimenters to reduce and analyze data in a timely fashion. A method of achieving this would be to reduce the volume of data that the experimenters receive without eliminating the information needed for analysis. Two techniques for reducing data volume are data compression and data selection.

Redundant data can be eliminated in a routine manner by performing data compression. Based on Apollo Program experience it should be possible to reduce sensor output data rates by a factor of 30.

There is an even greater opportunity to reduce data volumes by performing data selection. However, this approach requires a change in philosophy regarding data collection and the loss of data. Rather than collecting as much data as possible, only the most important data would be collected. This process could be aided by providing an interactive analysis capability, which would enable the experimenters to know exactly how their experiments are going and to make changes as required.



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MEMORANDUM FOR FILE

INTRODUCTION

The Goddard Space Flight Center (GSFC) is currently handling 3.5×10^9 bits per day from approximately 25 scientific satellites. One Skylab mission will produce at least 3.6×10^9 bits per day. The Space Station/Space Base will be capable of producing 7.5×10^{11} to 1.0×10^{13} bits per day. Thus one Skylab mission will produce more data than all the present scientific satellites combined and the Space Station/Space Base will be capable of producing 200 to 3000 times as much data as Skylab.

An obvious question is "How is this overwhelming volume of data going to be handled and who is going to analyze it in order to obtain meaningful experiment results?" Increasing NASA's data handling budget by a factor of 200 to 3000 isn't feasible and there certainly won't be 200 to 3000 times as many experimenters available to analyze the data. A good starting point in finding answers to the data problem is to review past experience.

INFORMATION VERSUS DATA

During the past five years the GSFC Central Processing Facility has accumulated a sizeable backlog of unprocessed data. The processing rate is such that an experimenter doesn't receive his data until several months after it has been acquired. This is true even though many improvements have been made at GSFC. The problem is that the combined daily volume of data from old and new satellites has increased by a factor of five during this period.

The experimenters also have large processing backlogs. For example solar astronomy data from ground based observatories and scientific satellites is being acquired much faster than it can be processed. At a recent solar astronomy conference experimenters from Harvard indicated that they spent months analyzing

data representing a single picture from OSO IV*. Much of the data experimenters receive is discarded as unusable because nothing of interest has occurred.

A similar situation has existed with engineering data. Less than half of the data acquired from Gemini earth orbital missions was processed.

Clearly there is a need to make it easier for scientists and engineers to reduce and analyze data in a timely fashion. A reasonable approach would be to reduce the volume of data that they receive without eliminating the information needed for analysis. This may be accomplished by using data compression and data selection techniques.

DATA COMPRESSION

Redundant data is created when the phenomenon being measured doesn't change as rapidly as the rate at which it is being sampled. This often occurs since experiments as well as engineering subsystems typically experience short active periods interspersed among longer passive periods. The sampling rates are selected so that information will not be lost during the active periods.

Using data compression techniques redundant data can be eliminated in a routine manner. Based on Apollo Program experience it appears likely that compression ratios of 30 to 1 can be achieved. In the Skylab Program plans are being made to perform data redundancy removal at the MSFN sites in order to take advantage of this situation. With this approach the large volume of data will still have to be handled onboard the Skylab, routed to the ground and handled at the MSFN sites. However, a reduced volume will be routed to the NASA Centers for analysis.

On future programs it would be preferable to perform data compression onboard the spacecraft. The sooner the data compression is performed in the series of data handling activities, the greater would be the opportunity for cost savings.

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*OSO IV is the Orbiting Solar Observatory IV scientific satellite.

DATA SELECTION

Data selection provides an even greater opportunity to hold data volumes to manageable levels than data compression. The data selection approach requires a change in philosophy regarding data collection and the loss of data. Experimenters must be convinced that they don't need to acquire as much data as possible in the first few months of operation of a Space Station/Space Base that will last ten years. It will not be necessary to structure experiments to cover all possible contingencies. Experimenters should collect the data that they think is most important and rerun experiments for additional data when it is necessary. The fear that something important might be missed should not compel experimenters to collect as much data as possible.

One method of assisting in data selection is through an interactive analysis concept. The concept is basically to provide experimenters the capability of knowing exactly how their experiments are going and to allow them to make changes as required.

This concept could be implemented by having the experimenters onboard the Space Station/Space Base, so that they could personally conduct their experiments. However, providing onboard facilities for individual experimenters does not appear to be feasible for the twelve man Space Station. An alternate approach for the Space Station would be to have a group of scientists and engineers onboard representing various experiment disciplines. They could conduct and monitor experiments, based on prepared plans and daily guidance provided by experimenters on earth. This concept could be implemented by providing varying amounts of real time and/or delayed time* data transmission to experimenters on the ground, so that they would have the information needed to direct the onboard activities.

CONCLUDING REMARKS

On future manned missions the data rates and mission durations will be considerably greater than at present. With data relay satellites it would be possible to acquire data up to 100% of the time. This combination, if unchecked, would

*Delayed time would be within hours.

result in overwhelming data processing loads. There would be much more data than the available scientists and engineers could assimilate. Therefore, some combination of data selection and data compression will be imperative.

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